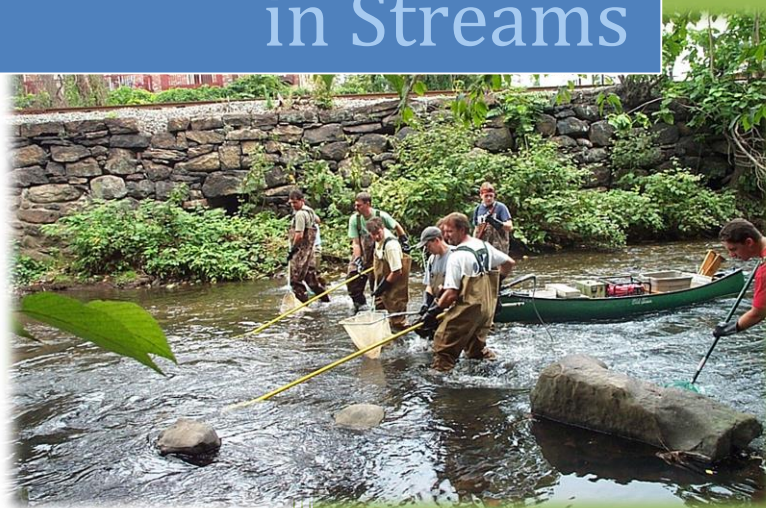


Federal Aid in Sport Fish Restoration  
F13AF00410  
F-57-R-33  
Annual Performance Report

2014-15

*Connecticut Inland Fisheries*

# Monitoring Fish Populations in Streams



Connecticut Department of Energy &  
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**State of Connecticut**  
**Department of Energy and Environmental Protection**  
**Bureau of Natural Resources**  
**Inland Fisheries Division**



Grant Title: Inland Fisheries Research and Management

Study 1: Coldwater Fisheries Program

Project: Coldwater Monitoring

Job 1: Monitoring Fish Populations in Streams

Period Covered: April 1, 2014 to March 31, 2015

Report Prepared by: Edward Machowski and Neal Hagstrom

Job Personnel: Edward Machowski, Job Leader  
Neal Hagstrom, Job Leader / Project Leader  
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Michael Humphreys, Primary Staff  
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Date Submitted: **XXXXXXXXXX, 2015**

Approved by: Peter Aarrestad  
Director, Inland Fisheries Division

William Hyatt  
Chief, Bureau of Natural Resources



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Cover photo: [DEEP IFD stream sampling crew. IFD file photo.]

## Summary

*The DEEP Inland Fisheries Division (IFD), in cooperation with the Bureau of Water Protection and Land Reuse (WPLR), electrofished a total of 191 streams in 2014. Of the 90 streams electrofished by IFD, 52 samples were paired with in-stream water temperature data (these include 14 long-term reference streams). These data will be used to document inter-annual and long-term changes in fish populations produced by climate, weather and various man-made effects. In Connecticut (CT), weather conditions were generally favorable for stream fish populations through June. However, extended high water events in late-spring/early summer may have had significant impacts on some fish species (e.g. stream smallmouth bass spawning success). Drought conditions plagued eastern CT (July – December), while western CT experienced only minor dry conditions from mid-August through December.*

## Background

Throughout the State's history many Connecticut streams became impaired by a variety of factors (industrialization, impoundment, flow diversion, pollution, development, and urban sprawl). More recently, many of those impacted streams have experienced improvements in water quality through flow naturalization or enhancement, upgrades of sewage treatment plants, and reductions in harmful industrial discharge. River flow can have a major effect on stream fish communities (Amstrong et al. 2011, Kanno and Vokoun 2010). Recently flows have been altered or "improved" to natural, "run-of-river" flow on the Housatonic (formerly "pond and release" flows) and augmented minimum flows on the Shepaug River (see Machowski et al. 2011 for flow alteration details). Regularly monitoring fish populations in rivers and streams that have undergone improvements (flow, physical or chemical) is one means to determine if these changes have successfully produced persistent, positive, long-term outcomes to the biological community.

In many areas, developmental pressures have not only caused habitat fragmentation due to dam and culvert construction, but have also exacerbated anthropogenic warming. Damming or ponding of stream water, loss of vegetation from stream banks ("riparian areas"), filled wetlands, increased impervious surfaces, effluent from wastewater treatment plants (WWTPs), and discharge from hydroelectric plants are all potential causes of warming ("thermal loading") in CT streams. The effects of these intentional and unintentional alterations need to be monitored so that they can be quantified and understood.

Water temperature greatly influences stream fish communities (Beauchene et al 2014). Warming water temperature is one of the principle factors threatening coldwater fish distributions in CT. Increases in average summer water temperature of two or three degrees Fahrenheit can change a stream capable of supporting over-summer trout survival to one that

can no longer do so (Lyons et al. 2009). Beauchene et al (2014) identified thermal classes/groups (“cold”, “cool”, “warm”) to more accurately predict stream fish community structure and to identify the likelihood of the presence of Brook Trout (a coldwater specialist fish species). In CT, streams classified as “cool” are at risk of losing sensitive coldwater species because there is little buffer against temperature increases that might be caused by impoundments, water diversions, riparian habitat destruction or a warming climate. Accurately documenting and monitoring stream resources is important for understanding potential changes in fish populations in waters expected to change from “cold” to “cool”, and from “cool” to “warm” (water temperatures for each category are defined in Approach section).

Our understanding of the influence of water temperature on stream fish survival is constantly expanding. Dams, culverts, and other in-stream obstructions often cause thermal loading. Conversely, groundwater inputs provide a cooling effect on stream temperatures. Monitoring and mapping stream water temperatures on a watershed scale is needed to identify specific sources or locations of thermal loading and conversely, cool/cold water inputs. Categorizing, color-coding and mapping stream water temperatures allows for an easily understood, visual representation of temperatures changes over an extended length of stream or selected time intervals. Mapping stream water temperatures is necessary to identify and protect fragile cool and cold water habitats. Additionally, artificial barriers cause stream fragmentation, often inhibiting or prohibiting the free movement of fish throughout a stream system. Documenting and mapping the locations of artificial barriers will enhance IFD’s ability, through its Habitat Conservation and Enhancement Program (HCE), to restore connectivity and instream habitat in many of CT’s streams. Information collected will also be used to identify potential new fishing opportunities produced by improved water quality or habitat.

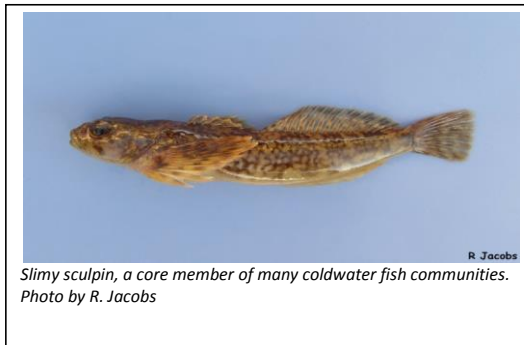
The 1988-1994 Statewide Stream Survey collected considerable baseline data on the State’s populations of stream fishes (Hagstrom et al. 1996). This information is now over 20 years old, and many streams have not yet been re-surveyed. During that time much of CT’s landscape has changed from developmental sprawl (e.g., developed land has increased from 16% to 19% statewide from 1985 to 2006) (CLEAR 2014) and indications are that the climate has indeed been changing (Adaptation Subcommittee 2011). Re-sampling of historic survey sites, coupled with long-term sampling of selected reference streams and collection and analysis of water temperature data, will document if range shifts of fish species has occurred due to man-made or environmental/climatic changes. Data collected under this Job, along with time-series data collected under the Wild Trout Job (Coldwater Management Project, Job 4) and fish community assessments done by CT’s Water Protection and Land Reuse (WPLR) staff, will provide a robust data set that will aid in making future management decisions.

This Job fosters close cooperation between the DEEP IFD and WPLR as well as other “cooperators” outside the DEEP (e.g., watershed associations, Trout Unlimited chapters, town

commissions, and The Nature Conservancy) that routinely collect water quality data. Cooperative data sharing minimizes costs and redundancy in effort. Additionally, these data are being shared and used to develop regional models/predictors for important cold-water stream species (i.e. brook trout in New England). By utilizing water quality data collected by cooperators, the ability of IFD to assess changes in stream habitat and fish communities is greatly enhanced. Similarly, the data collected by IFD are of use and of interest to groups outside our division, and we are investigating methods to best disseminate this information to them (e.g., GIS coverage's, public access portals).

## Objectives

- Monitor streams where water quality or physical habitat has been improved or has become degraded.
- Assess resident fish populations in both the Shepaug and Housatonic rivers to document if flow alterations produce changes in fish populations.
- Assess fish populations of headwater streams, with emphasis on temperature-sensitive coldwater species.
- Conduct water temperature mapping of stream networks to locate sources of thermal loading (e.g., cleared riparian stream corridors, instream impoundments, surface or ground water influences), identify key thermal refuge areas, and assign thermal classifications to streams.
- Develop systems to map manmade or natural barriers/obstructions to fish movement.
- Assess short and long term environmental trends by regularly sampling reference (sentinel) streams (cold, cool and warm water) and by re-sampling selected 1988-1994 Stream Survey sites.
- Standardize and archive stream survey data, and make information available to the HCE program, other divisions within the DEEP, town land use commissions, and the public upon request. Additionally, share these important data for use in regional planning for adaptive measures to climate change, aimed at mitigating potential threats to stream dwelling, cold-water specialist species.

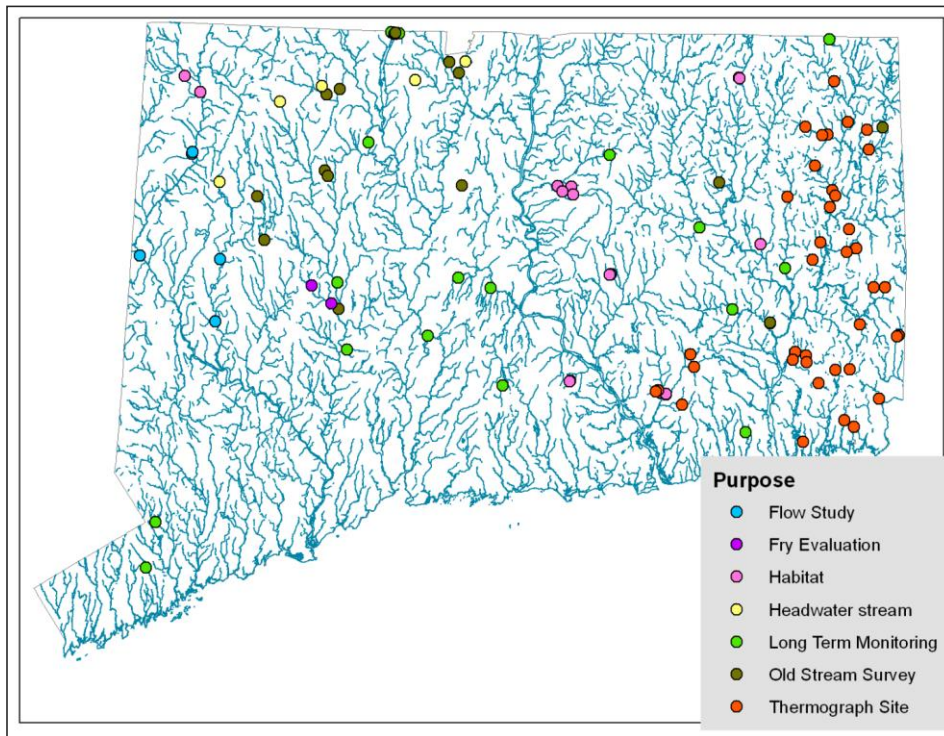


## Approach

- Abundance and size distributions of stream fish are monitored by electrofishing following standard sampling protocols outlined by Hagstrom et al. 1996.
- Long term reference sites selected by water temperature-habitat type (based on average hourly summer (June – August) water temperature metrics derived by Beauchene et al, 2014 as: cold (< 64.9°F), cool (64.9°F – 71.1°F), warm (>71.1°F)) and geographic location are periodically (each stream is sampled on a 3 year rotation; to avoid possible bias imposed by annual electrofishing) sampled for fish species composition and abundance, and monitored year-round for water temperature.
- Sites from the 1988-1994 Stream Survey are selected for re-surveying based on the following criteria: 1) length of time since last sample, 2) specific requests for sampling by agency personnel, 3) opportunity to obtain fish population data that can be paired with current water temperature data, and 4) the need to assess recent habitat changes.
- Water temperatures are continuously recorded from May through October (in some cases year-round) using Onset data loggers in selected stream networks.
- Stream crossings are assessed to identify man-made barriers (e.g. culverts, bridges) to fish movement. Each crossing is mapped, measurements and photographs are taken of each barrier, and the data are then stored in Geo Referenced databases and viewed through a limited access portal.
- Appropriate statistical techniques (e.g., multivariate cluster analyses, TITAN analyses (Baker and King 2010) are used to classify and describe changes in stream fish communities.

## Key Findings

- During 2014, fish population data were collected from 191 streams (Appendix 1; Figure 1) and all data were compiled and entered into a centralized database. Streams were separated into the following categories:
  - Water resource monitoring (sampled by IFD at the request of WPLR): 3
  - Habitat altered streams: 8
  - Water quality altered streams including fish contaminant analysis: 4
  - General survey streams including water temperature monitoring streams: 58
  - Trout fry/fingerling stocked streams: 1
  - Long-term water temperature monitoring and reference streams: 16
  - WPLR streams (streams sampled solely by WPLR personnel): 101



**Figure 1.** Locations of the 90 streams sampled by IFD in 2014. Not shown are the 101 streams sampled by WPLR personnel.

#### *Weather Conditions:*

Local and regional weather (temperature and rainfall) can play a large role in spawning success, survival and growth of stream fishes. Documenting weather related effects on stream fishes can vary greatly from one geographic location to another, even in a state as small as Connecticut. The following is an overall account of the weather from 2014 taken from the National Weather Service at Bradley International Airport.

*\* The term "normal" is used repeatedly in the following weather description and refers to the average of long term data collected daily, monthly and annually from the weather reporting station at Bradley International Airport. Deviations in precipitation or temperature can then be compared to what is considered to be normal or average for that period of time in Connecticut.*

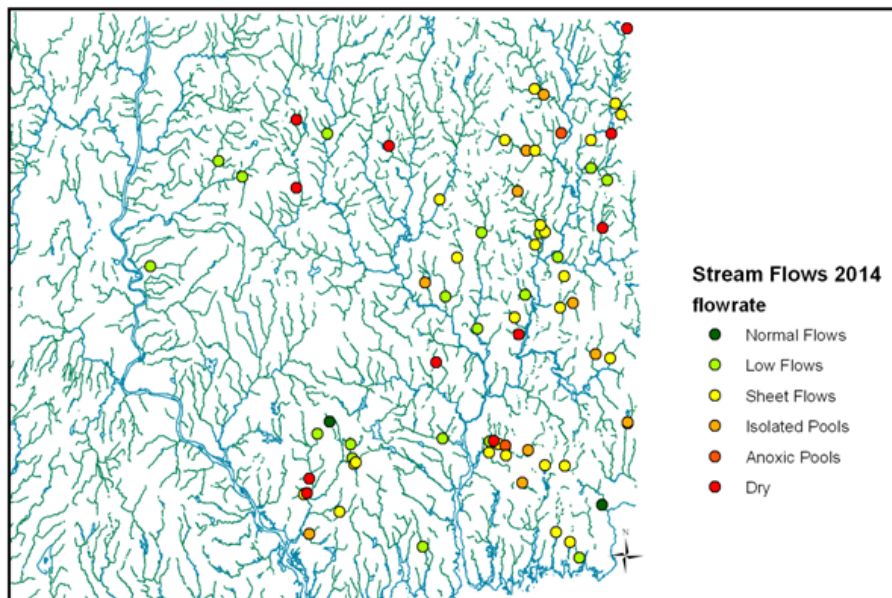
- Weather conditions in 2014 (January through December) according to the NOAA National Weather Service (Bradley International Airport data) were cooler than normal (-4.3°F) with slightly less than normal precipitation (-0.02 inches).
- Minor to moderate drought conditions were apparent early on in 2014 throughout CT following drier than normal conditions beginning in late fall of 2013 (Appendix 2a and 2b). However, total precipitation was above normal (4.2 inches) for the first half of 2014 (January through May) which alleviated drought conditions throughout the state. The second half (June through November) was below normal in precipitation (-5.33 inches), and December was 1.11 inches above normal.
- The most pronounced deficit in rainfall occurred in the eastern/south eastern portion of the state, while western, and most notably the northwest region experienced little to no drought conditions during 2014.
- Average air temperatures at Bradley Airport were 4.3°F below normal for the year with a total of only 15 days over 90°F (typical for Bradley Airport is 14.6 days over 90°F annually). Spring (January–May) temperatures were cold (13°F below normal) and no “heat wave” (a stretch of 3 or more 90°F+ days) was experienced in 2014.
- Stream conditions based on weather were favorable (cool/ample water) in western CT throughout 2014. In contrast, streams in eastern CT, while cool, experienced deteriorating flow conditions beginning in mid-summer and remained low throughout the remainder of the year (Figure 2).

#### *Flow-Altered Streams:*

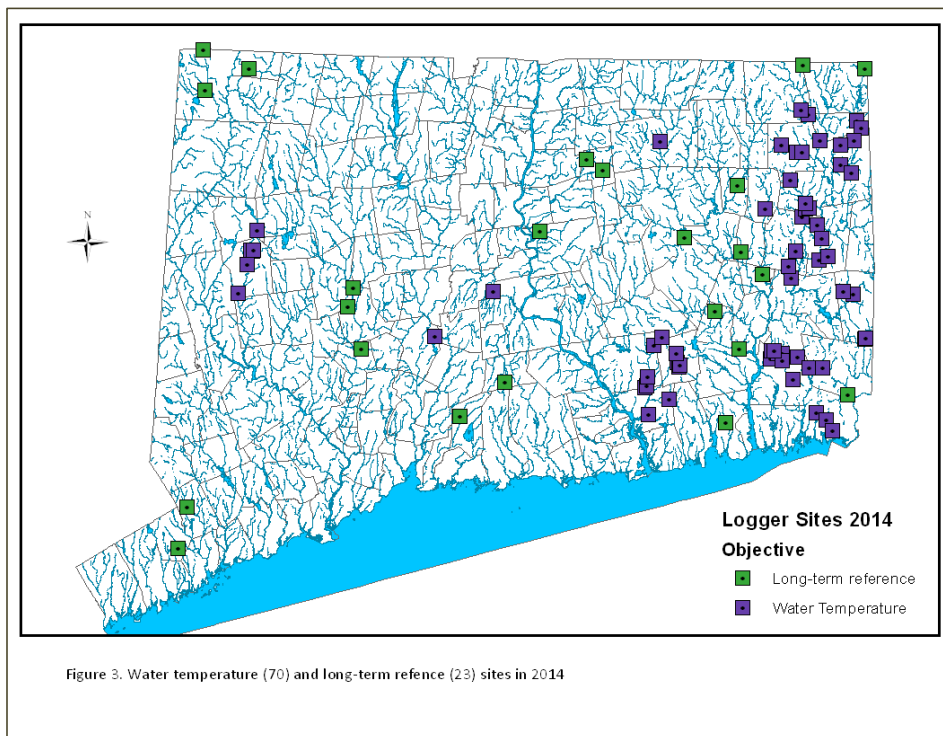
Two rivers in western CT that have undergone significant flow alterations within the last 10 years (Housatonic River in 2006 and Shepaug River in 2009; Machowski et al. 2011) were sampled at standard locations in 2014 to assess stream fish population changes with respect to stream flow. Data/analyses were presented in Machowski et al. 2013 for the Shepaug River. Further analyses for both the Shepaug River and Housatonic River will be presented in the Final Report.

#### *Water Temperature Monitoring*

A total of 93 thermographs were deployed in CT during 2014 (Figure 3). Out of those, paired water temperature/fish abundance data were collected from 38 streams (Appendix 1). These data are being used to evaluate water diversion permits, and develop seasonal indices based on water temperature to help predict fish community changes due to changes in temperature.



**Figure 2. Early fall stream flows documented in Eastern CT, 2014**



#### *Long-term Reference Streams:*

Beginning in 2013, a suite of 23 streams was selected (based on known habitat type “cold, cool, warm”) statewide as “long-term reference” streams. Thermographs were deployed in some of the streams in 2013 and the remainder in 2014. Fish community data were collected in 14 out of the 23 streams in 2014. Data are being used to monitor trends in fish distribution and community structure as they are related to stream water temperature and potential future changes.

IFD has sampled two long-term reference streams (Mattabesset River, Berlin and Valley Brook, Hartland) for trout almost every year since 2000. Data from these streams/stream sections, which are closed to angling, allows IFD to assess year-to-year fluctuations in trout abundance produced solely by variation in environmental conditions.

Data (water temperature and fish) will be analyzed and presented for all reference streams in the upcoming Final Job Report.

### *Stream Crossing Assessments*

Since 2009, over 2,500 stream crossings (culverts, bridges, etc.) were identified and documented in eastern CT. To date, work has been completed in 33 towns, and work is in progress in an additional 17 towns (Appendix 3). Preliminary work to inventory stream crossings was begun in western CT in 2014.

In cooperation with the HCE Program at IFD, initial work was begun to develop geo-referenced data sets that will allow us to evaluate the effects of different types of barriers on fish distribution using real world data rather than relying on laboratory predictions. The dataset intersects: 1) fish population data upstream and downstream of a barrier, 2) measured physical barrier parameters, and 3) the National Hydrological Data set (NHD2+) to allow analyses across a range of situations. It is hoped we will have these datasets completed for presentation in the Final Segment report.

### *Fry Stocking Evaluation:*

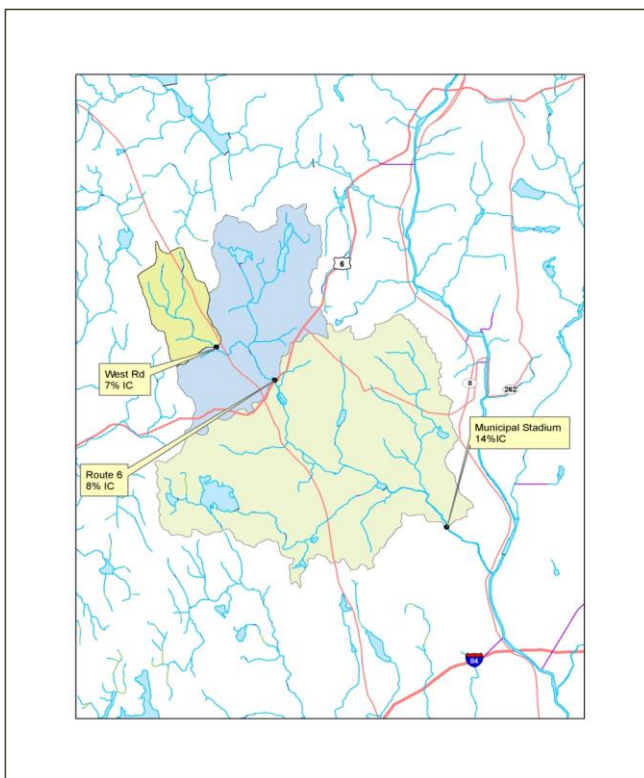
Steele Brook (Watertown) has been stocked with Brown Trout fry since 2005 in two standard stream sections. In May 2014, a total of 10,000 Seeforellen fry were equally stocked between the two sites. Densities (#/hectare) of stocked fry sampled in September of 2014 was near the average of the past 8 years for both locations (Upper Area - 1,171 vs. 8 yr average = 1,460; Lower Area – 230 vs. 8 yr average = 388). In addition, 57/ha yearling (1+) and 28/ha older (2+) Brown Trout were sampled in the Upper Area.

## **Discussion**

The disparity in Brown Trout fry survival between the two fry-stocked sections of Steele Brook is largely due to habitat stability and quality differences. The upper stream section of Steele Brook (above the Route 6 crossing) is above the influence of dams, has cooler (Avg. June 15<sup>th</sup> - Sept 15<sup>th</sup> = 19°C) water temperatures and more stable habitat (less impervious surface (~8%) in the upper drainage and less prone to flash flooding). Whereas the lower stocked location (Municipal Stadium) is below two dammed impoundments, is warmer (Avg. June 15<sup>th</sup> – Sept 15<sup>th</sup> = 21°C), and more urbanized with a higher percentage (~12%) of impervious cover in the contributory drainage (Figure 4). The higher percentage of impervious cover within the drainage area of the Municipal Stadium stream reach makes this area very prone to flash

floods. Consequently, the in-stream habitat is in constant flux. Annual shifts in stream channel following high flow events are not uncommon.

As stream habitat improves with anticipated dam removal, it may be possible to develop a viable trout fishery in this metropolitan stream. Interestingly, local anglers who frequent the upper stream location have reported catching Brown Trout up to 16 inches. Further analysis of water temperature data, assessment of flow alterations on both the Shepaug River and Housatonic River, stream crossing assessments, riverine smallmouth bass management assessment, and a full review of species distribution in CT streams will be presented in the 2016 Final Report.



**Figure 4.** Percent impervious cover at two stocked locations on Steele Brook, Watertown.

## Recommendations

- ◆ Evaluate paired stream crossing and fish population data to determine effects of small stream barriers on fish populations.
- ◆ Monitor dissolved oxygen and water temperature within upper and lower sections of the Shepaug River through the summer.

## Expenditures

Total Cost: \$xxx,xxx  
Federal Share: \$xxx,xxx  
State Share: \$xxx, xxx

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## Acknowledgements

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## Appendices

**Appendix 1.** List of streams sampled in 2014 by category.

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Stream Name	Date	Reason for Sampling	Number Sites	Number Streams
1) Water Resources Monitoring Sites				3
Hubbard Brook, Hartland	07/07/14	Ambient Monitoring	1	(3 sites)
Hurricane Brook, Hartland	07/08/14	Ambient Monitoring	1	
Shepaug River, Roxbury	08/05/14	Ambient Monitoring	1	
2) Habitat-Altered Sites				8
Beaver Meadow Brook, Haddam	09/17/14	Post-culvert Replacement	2	(17 sites)
Bigelow Brook, Manchester	07/17/14	Pre-Dam Removal	1	
East Branch Eightmile Brook, Lyme	07/10/14	Dam Removal Evaluation	2	
Leadmine Brook, Ashford	07/24/14	Post-culvert Replacement	2	
Lyman Brook Trib., Marlborough	07/23/14	Post-culvert Replacement	2	
Merrick Brook, Scotland	07/28/14	Post-habitat Enhancement	3	
Salmonkill Creek, Salisbury	09/18/14	Pre-habitat Enhancement	2	
South Fork Hop Brook, Manchester	07/17/14	Post-Fire Effluent Evaluation	3	
3) Water Quality-Altered Sites				4
Eightmile River, Southington	07/10/14	Contaminant Evaluation/WPLR	1	(9 sites)
Housatonic River, Cornwall-Kent	9/5-9/8/14	Water Flow Evaluation	3	
Quinipiac River, Southington	07/11/14	Contaminant Evaluation/WPLR	1	
Shepaug River, Litchfield-Washington	8/4-8/20/14	Water Flow Evaluation	4	
4) General Survey Sites				58
Beaver Brook, Salem	08/22/14	General Information/Thermograph	1	(64 sites)
Billings Brook, Griswold	06/26/14	General Information/Thermograph	1	
Carpenter Brook, Putnam	07/31/14	General Information/Thermograph	1	
Cold Spring Brook, Brooklyn	07/15/14	General Information/Thermograph	1	
Cranberry Meadow Brook, East Haddam	08/22/14	General Information/Thermograph	1	
Creamery Brook, Brooklyn	07/15/14	General Information/Thermograph	1	
Crowley Brook, Preston	08/05/14	General Information/Thermograph	1	
East Branch Eightmile River, Lyman	07/10/14	General Information/Thermograph	2	
Fivemile River, Killingly	06/20/14	General Information/Thermograph	1	
Frazer Brook, Salem	07/23/14	General Information/Thermograph	1	
Great Meadow Brook, Voluntown	08/22/14	General Information/Thermograph	1	
Green Fall Brook, Voluntown	06/26/14	General Information/Thermograph	1	
Hewitt Brook, Preston	08/04/14	General Information/Thermograph	1	
Hockanum River, Vernon	07/11/14	General Information/Thermograph	1	
Kelly Brook, Killingly	06/20/14	General Information/Thermograph	1	
Little River, Hampton	07/08/14	General Information/Thermograph	1	
Lowden Brook, Voluntown	06/26/14	General Information/Thermograph	1	
Malt House Brook, East Haddam	08/22/14	General Information/Thermograph	1	
Mashamoquet Brook, Pomfret	06/13/14	General Information/Thermograph	2	
Nightingale Brook, Pomfret	07/31/14	General Information/Thermograph	1	
Peake Brook, Woodstock	07/15/14	General Information/Thermograph	1	
Pegmill Brook, Voluntown	06/26/14	General Information/Thermograph	1	
Sandy Brook, Brooklyn	07/15/14	General Information/Thermograph	1	
Sap Tree River, Pomfret	07/31/14	General Information/Thermograph	1	
Upper Harris Brook, Salem	07/23/14	General Information/Thermograph	1	
Whetstone Brook, Killingly	06/20/14	General Information/Thermograph	1	

Appendix 1. continued.

Stream Name	Date	Reason for Sampling	Number Sites	Number Streams
<b>4) General Survey Sites con't</b>				
Bobbin Mill Brook	06/20/14	General Information/Old SS Site	2	
Bradley Brook, Granby	08/19/14	General Information	1	
Colebrook Brook, Winchester	08/18/14	General Information/Old SS Site	1	
Copps Brook, Stonington	08/05/14	General Information/Thermograph	1	
Cory Brook, Canterbury	08/19/14	General Information	1	
Fenton River, Mansfield	06/12/14	General Information/Training	1	
Fort Hill Brook, Groton	08/06/14	General Information	1	
Hatchery Brook, Berlin	09/03/14	General Information/Old SS Site	1	
Horse Brook, Plainfield	08/19/14	General Information/Thermograph	1	
Hungary Brook, Granby	08/19/14	General Information/Old SS Site	2	
Joe Clark Brook, Ledyard	08/04/14	General Information/Thermograph	1	
Kitt Brook, Canterbury	08/12/14	General Information/Thermograph	1	
Lantern Hill Brook, North Stonington	08/06/14	General Information/Thermograph	1	
Lathrop Brook, Plainfield	08/19/14	General Information/Thermograph	1	
Lee Brook, Ledyard	08/06/14	General Information/Thermograph	1	
Mad River, Winsted	08/06/14	General Information/Old SS Site	1	
Mill Brook, Plainfield	08/19/14	General Information/Thermograph	1	
Naugatuck River, Waterville	08/27/14	General Information	1	
NNT in Enders SF, Granby	08/19/14	General Information	1	
NNT to Hall Meadow Brook, Norfolk	08/18/14	General Information	1	
Phelps Brook, North Stonington	08/06/14	General Information/Thermograph	1	
Rose Hill Brook, Ledyard	08/04/14	General Information	1	
Shunock Brook, Stonington	08/05/14	General Information/Thermograph	1	
Still River, Winchester	08/06/14	General Information/Old SS Site	1	
Stony Brook, Stonington	08/05/14	General Information/Thermograph	1	
Tatnic Brook, Canterbury	08/12/14	General Information/Thermograph	1	
Valley Brook, Hartland	07/28/14	General Information/Old SS Site	1	
West Br. Shepaug River, Cornwall	08/18/14	General Information/Old SS Site	1	
West Branch Butternut Brook, Litchfield	08/05/14	General Information/Old SS Site	1	
West Branch Ledmine Brook, Harwinton	08/06/14	General Information/Old SS Site	2	
Whittlesey Brook, Morris	08/05/14	General Information/Old SS Site	1	
<b>5) Fry and Fingerling Stocking</b>				1
Steele Brook, Watertown	09/12/14	Fry Survival Evaluation	2	(2 sites)
<b>6) Long term reference streams</b>				16
Coginchaug River, Durham	08/01/14	Longterm Temperature Monitoring	1	(18 sites)
Comstock Brook, North Wilton	07/16/14	Longterm Temperature Monitoring	1	
Fivemile River, New Canaan	07/16/14	Longterm Temperature Monitoring	1	
Fulling Mill Brook, Naugatuck	07/16/14	Longterm Temperature Monitoring	1	
Hockanum River, Vernon	07/11/14	Longterm Temperature Monitoring	1	
Jordan Brook, Waterford	08/01/14	Longterm Temperature Monitoring	1	
Little River, Hampton	07/08/14	Longterm Temperature Monitoring	1	
Mattabesset River, Berlin	5/21; 11/4/14	Reference	2	
Mattabesset River, Berlin	09/03/14	Longterm Temperature Monitoring	1	
Naugatuck River, Thomaston	08/27/14	Longterm Temperature Monitoring	1	
Quinebaug River, Thompson	06/13/14	Longterm Temperature Monitoring/WPLR	1	
Quinipiac River, Meriden	08/01/14	Longterm Temperature Monitoring	1	
Tankerhoosen River, Vernon	08/26/14	Longterm Temperature Monitoring	1	
Tennile River, Columbia	07/08/14	Longterm Temperature Monitoring	1	
Valley Brook, East Hartland	07/28/14	Reference	2	
Yantic River, Bozrah	07/08/14	Longterm Temperature Monitoring	1	

Appendix 1. continued.

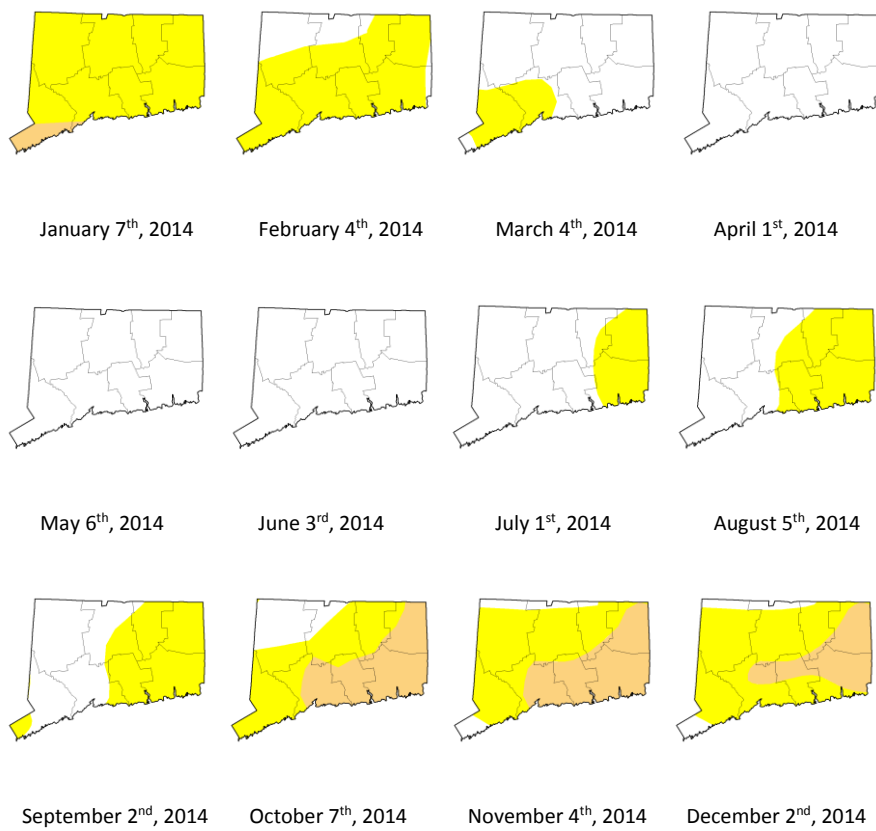
**Commented [TB1]:** Pete says its not the Water Bureau anymore, need correct name.

Stream Name	Date	Reason for Sampling	Number Sites	Number Streams 101
<b>7) Sites sampled by Water Bureau Personnel</b>				
Bonemill Brook, Tolland	06/20/14	WPLR	1	(115 sites)
Branch Brook, Eastford	06/26/14	WPLR	1	
Bungee Brook, Eastford	07/11/14	WPLR	1	
Cherry Brook, Canton	06/04/14	WPLR	1	
Cromwell Creek, Cromwell	06/25/14	WPLR	1	
Dark Hollow Brook, Voluntown	07/30/14	WPLR	1	
Eagleville Brook, Mansfield	06/20/14	WPLR	4	
East Branch Mount Hope, Ashford	06/26/14	WPLR	1	
Eightmile Brook, North Haven	07/31/14	WPLR	1	
Eightmile River, East Haddam	07/17/14	WPLR	1	
Ekonk Brook, Plainfield	07/10/14	WPLR	1	
Fenton River, Willington	06/12/14	WPLR	3	
Fivemile River, Thompson	06/11/14	WPLR	1	
Fry Brook, Plainfield	07/08/14	WPLR	1	
Fulling Mill Brook, Naugatuck	06/04/14	WPLR	1	
Gardner Brook, Bozrah	06/19/14	WPLR	1	
Great Meadow Brook, Voluntown	07/08/14	WPLR	1	
Hewitt Brook, Preston	07/09/14	WPLR	1	
Hockanum River, Vernon	07/11/14	WPLR	1	
Hop River, Coventry	07/02/14	WPLR	1	
Hunts Brook, Waterford	07/17/14	WPLR	2	
Kahn Brook, Bozrah	06/19/14	WPLR	1	
Lebanon Brook, Woodstock	06/26/14	WPLR	1	
Merrick Brook, Scotland	07/18/14	WPLR	1	
Middle River, Stafford	06/06/14	WPLR	1	
Middle River, Stafford	06/27/14	WPLR	1	
Muddy Brook, Woodstock	06/26/14	WPLR	1	
Murphy Brook, Hampton	07/10/14	WPLR	1	
Nod Brook, Avon	06/25/14	WPLR	1	
Norwalk River, Wilton	07/31/14	WPLR	1	
Oxoboxo Brook, Montville	07/09/14	WPLR	1	
Oxoboxo Brook, Montville	07/16/14	WPLR	2	
Pease Brook, Bozrah	06/19/14	WPLR	1	
Quanduck Brook, Sterling	07/10/14	WPLR	1	
Roaring Brook, Willington	06/06/14	WPLR	1	
Rocky Brook, Thompson	06/11/14	WPLR	1	
Salmon Brook, Glastonbury	06/25/14	WPLR	1	
Sawmill Brook, Mansfield	06/27/14	WPLR	1	
Skungamaug River, Coventry	07/02/14	WPLR	1	
Spice Brook, Tolland	07/02/14	WPLR	1	
Stickney Hill Brook, Union	06/06/14	WPLR	1	
Still River, Eastford	07/11/14	WPLR	1	
Stony Brook, Montville	07/16/14	WPLR	1	
Susquetonscut Brook, Franklin	06/19/14	WPLR	1	
Trading Cove Brook, Norwich	07/09/14	WPLR	1	
Transylvania Brook, Southbury	07/24/14	WPLR	3	
Waldo Brook, Sprague	07/17/14	WPLR	1	
Wappoquia Brook, Pomfret	06/11/14	WPLR	1	
Wash Brook, Bloomfield	05/30/14	WPLR	1	
Wewaka Brook, Bridgewater	07/24/14	WPLR	1	
Whetstone Brook, Killingly	07/08/14	WPLR	1	
Willimantic River, Mansfield	06/27/14	WPLR	2	
Willimantic River, Mansfield	07/03/14	WPLR	1	
Yantic River, Bozrah	07/18/14	WPLR	1	

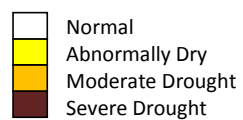
Appendix 1. continued.

Stream Name	Date	Reason for Sampling	Number Sites	Number Streams
<b>7) Sites sampled by Water Bureau Personnel con't</b>				
Bear Swamp Brook, Coventry	08/20/14	WPLR	1	
Blackwell Brook, Brooklyn	08/01/14	WPLR	1	
Brooks Brook, Tolland	08/21/14	WPLR	1	
Burnap Brook, Andover	08/20/14	WPLR	1	
Clover Brook, Scotland	08/22/14	WPLR	1	
Delphi Brook, Stafford	08/29/14	WPLR	1	
Diamond Ledge Brook, Stafford	08/26/14	WPLR	1	
E. Branch Stonehouse Brook, Chaplin	08/08/14	WPLR	1	
Ellis Brook, Stafford	08/26/14	WPLR	1	
Fall Brook, Killingly	08/21/14	WPLR	1	
Furnace Brook, Stafford	08/26/14	WPLR	1	
Gravelly Brook, Woodstock	08/14/14	WPLR	1	
Grover Brook, Tolland	08/21/14	WPLR	1	
Hempstead Brook, Groton	08/08/14	WPLR	1	
Indian Hollow Brook, Windam	08/22/14	WPLR	2	
Knowlton Brook, Willington	08/21/14	WPLR	1	
Little Dam Tavern Brook, Putnam	08/27/14	WPLR	1	
Lowry Brook, Willington	08/21/14	WPLR	1	
Main Brook, W. Branch Headwater, Preston	08/28/14	WPLR	1	
Mary Brown Brook, Putnam	08/27/14	WPLR	1	
Mascraft Brook, Thompson	08/15/14	WPLR	1	
Mashamoquet Brook, Pomfret	08/01/14	WPLR	1	
McCarthy's Brook, Franklin	08/07/14	WPLR	1	
McIntyres Brook, Stafford	08/29/14	WPLR	1	
Mill Brook, Cornwall	08/05/14	WPLR	2	
Mill Brook, Woodstock	08/14/14	WPLR	2	
Miller Brook, Preston	08/28/14	WPLR	1	
Moosup River, Plainfield/Sterling	08/06/14	WPLR	2	
Moritz Brook, Ashford	08/21/14	WPLR	1	
Natchaug River, Chaplin	08/06/14	WPLR	1	
Peckham Brook, Woodstock	08/14/14	WPLR	1	
Potash Brook, Stafford	08/26/14	WPLR	1	
Pottens Brook, Windam	08/22/14	WPLR	1	
Reed Brook, Coventry	08/20/14	WPLR	1	
Rufus Brook, Coventry	08/20/14	WPLR	1	
Shady Oak Brook, Putnam	08/27/14	WPLR	1	
Shady Oak Schoolhouse Brook, Putnam	08/27/14	WPLR	1	
Shetucket River, Windam	08/07/14	WPLR	1	
Snake Meadow Brook, Plainfield	08/21/14	WPLR	1	
Squaw Hollow Brook, Ashford	08/21/14	WPLR	1	
Stoud Brook, Thompson	08/14/14	WPLR	1	
Taylor Brook, Woodstock	08/15/14	WPLR	1	
Tenmile River, Lebanon	08/07/14	WPLR	1	
Tennant Brook, Plainfield	08/21/14	WPLR	1	
West Brook, Tolland	08/29/14	WPLR	1	
Whitford Brook, Groton	08/08/14	WPLR	1	
Wood Brook, Plainfield	08/21/14	WPLR	1	

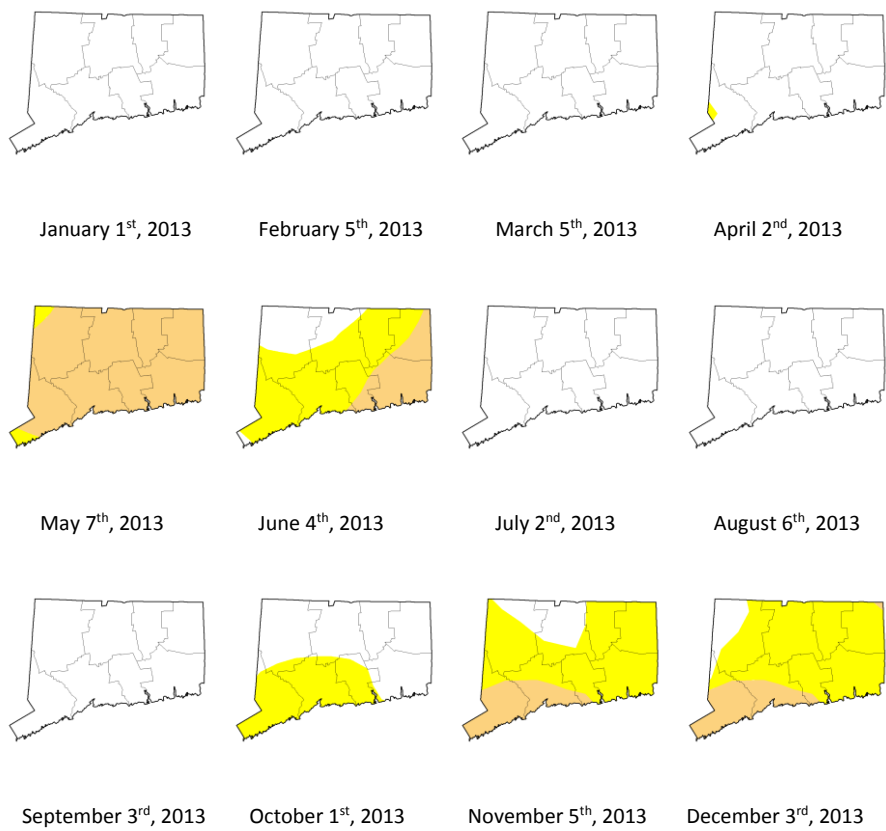
**Appendix 2a.** Drought conditions from January, 2014 through December, 2014. Maps depict regional changes in drought conditions throughout the state. Maps courtesy of U. S. Drought Monitor.



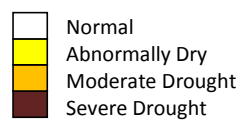
**Drought Status**



**Appendix 2b.** Drought conditions from January, 2013 through December, 2013. Maps depict regional changes in drought conditions throughout the state. Maps courtesy of U. S. Drought Monitor.



**Drought Status**



**Appendix 3.** Status of stream crossing (culverts/bridges) evaluation by town from 2009 – 2014.

<u>Town</u>	<u>Status</u>	<u>Primary Surveyor</u>
Andover	Complete	DEEP IFD Staff
Ashford	Partial/State Forest Only	DEEP IFD Staff
Avon	Partial	Trout Unlimited
Bolton	Complete	DEEP IFD Staff
Bozrah	Complete	Trout Unlimited
Canton	Partial	Trout Unlimited
Chaplin	Partial/State Forest Only	DEEP IFD Staff
Cheshire	Partial	Trout Unlimited
Colchester	Complete	DEEP IFD Staff
Columbia	Complete	DEEP IFD Staff
Coventry	Complete	DEEP IFD Staff
Durham	Partial	Trout Unlimited
Eastford	Partial	DEEP IFD Staff
East Haddam	Partial	Watershed Assoc.
East Hampton	Complete	DEEP IFD Staff
East Lyme	Partial	Volunteer
Farmington	Partial	Watershed Assoc.
Glastonbury	Complete	DEEP IFD Staff
Griswold	Complete	DEEP IFD Staff
Groton	Complete	DEEP IFD Staff
Guildford	Partial	Trout Unlimited
Haddam	Partial	Trout Unlimited
Hebron	Complete	DEEP IFD Staff
Killingly	Complete	DEEP IFD Staff
Lebanon	Complete	Trout Unlimited
Ledyard	Complete	DEEP IFD Staff
Lisbon	Complete	Trout Unlimited
Lyme	Complete	Watershed Assoc.
Marlborough	Complete	DEEP IFD Staff
Meriden	Partial	Volunteer
Middlefield	Partial	Trout Unlimited
North Stonington	Complete	DEEP IFD Staff
Old Lyme	Complete	Watershed Assoc.
Portland	Complete	DEEP IFD Staff
Preston	Complete	Trout Unlimited
Putnam	Complete	DEEP IFD Staff
Salem	Complete	DEEP IFD Staff

**Appendix 3.** Continued.

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<b><u>Town</u></b>	<b><u>Status</u></b>	<b><u>Primary Surveyor</u></b>
Southington	Partial	Volunteer
South Windsor	Complete	DEEP IFD Staff
Sprague	Complete	Trout Unlimited
Stafford	Partial	Volunteer
Sterling	Complete	DEEP IFD Staff
Stonington	Complete	DEEP IFD Staff
Thompson	Complete	DEEP IFD Staff
Tolland	Complete	DEEP IFD Staff
Torrington	Partial	Volunteer
Union	Complete	DEEP IFD Staff
Vernon	Complete	DEEP IFD Staff
Voluntown	Complete	DEEP IFD Staff
Wallingford	Partial	Trout Unlimited
Waterford	Partial	DEEP IFD Staff
West Hartford	Partial	Volunteer
Willington	Partial	DEEP IFD Staff
Woodstock	Complete	DEEP IFD Staff

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